

## **Paleoseismology Study in the Cache River Valley, Southern Illinois**

The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. Government.

USGS Award No: 1434-HQ-98-GR-00013 (TAMU)

USGS Award No: 1434-HQ-98-GR-00015 (M. Tuttle & Associates)

### **Annual Project Summary**

Judith S. Chester

Texas A & M University

Department of Geology and Geophysics

College Station, TX 77843

Tel: 979-845-1380

Fax: 979-845-6162

e-mail: [chesterj@geo.tamu.edu](mailto:chesterj@geo.tamu.edu)

URL: <http://geoweb.tamu.edu/Faculty/chesterj>

Martitia P. Tuttle

M. Tuttle & Associates

HC 33 Box 48

Georgetown, ME 04548

Tel: 207-371-2796

Fax: 207-371-2834

e-mail: [mptuttle@erols.com](mailto:mptuttle@erols.com)

Program Element: I

**Key Words:** Paleoseismology, Paleoliquefaction, Quaternary Fault Behavior, Age Dating

### **Investigations Undertaken**

This paleoseismology investigation of the Cache River Valley (CRV) of southern Illinois is a collaboration between J. Chester (TAMU) and M. Tuttle (M. Tuttle & Associates) with contributions by E. Schweig (USGS), J. Sims (John Sims and Associates; formerly of USGS) and B. Noonan (M.S. student at TAMU). The main goals of the project are to (1) study and describe in detail earthquake-induced liquefaction features and post-Cretaceous faults identified during our 1997 reconnaissance, (2) conduct a systematic search for additional earthquake-related features along the Cache River and several of its tributaries to provide information for estimating the timing and magnitudes of prehistoric earthquakes, (3) study the relations between faults, regional structures and seismicity, and (4) evaluate the relations between the size distribution of liquefaction features and possible earthquake sources in the CRV, New Madrid seismic zone, and Wabash Valley seismic zone.

The CRV is located along the northern margin of the Mississippi embayment, immediately northeast of the New Madrid seismic zone and southwest of the Wabash Valley seismic zone. Small to moderate earthquakes are common in this region, though less frequent than in the surrounding seismic zones. The CRV is located between several major fault systems including the Fluorospa Area fault complex to the east, Commerce fault system to the west, and Ste. Genevieve/Iron Mountain fault system to the northwest (Figure 1). Some significant post-Cretaceous faulting has occurred in these regions (e.g., Harrison and Schultz, 1994; Nelson, 1995; Nelson et al., 1997; Hoffman et al., 1996).

## Results

During the 1999-2000 field seasons, we searched 38 km of the lower Cache River from Ullin, Illinois, to the Mississippi River (Figure 1). We also logged deformation structures at one site and plan to return to another site in the fall of 2000 for further study. In addition, we will resurvey the portion of the Cache River from Ullin to Sandusky, Illinois, that was poorly exposed during reconnaissance due to high water levels.

Along 25 km of the Cache River from Sandusky to the Mississippi River via the diversion channel, we found six sand dikes at four different sites. The sand dikes range from 1-9 cm wide and pinch upward, extending to 1.1 m above the water table or 2.4 m below the top of the cutbank. The dikes range in grain-size from silty, fine sand to medium sand and contain small clasts of the silty host deposit. At three of the sites, the dike tips are characterized by silt in the matrix and fines coating sand grains. At the fourth site, the dikes are composed of clean, fine sand with little silt in the matrix even at the tip. Differences in weathering characteristics may indicate two generations of sand dikes, with the dikes containing clean sand being the younger. At the fourth site, a piece of charcoal was collected 30 cm below the tip of the sand dike that extends highest in the cutbank. Radiocarbon dating of the charcoal yielded a two-sigma calibrated date of A.D. 1020 to 1250. This represents a maximum age for the sand dikes at the site and indicates that the younger generation of dikes, and possibly the older generation as well, formed after A.D. 1020. It will be difficult to establish the minimum age of the sand dikes because none of them appear to have propagated to the ground surface or to have been truncated by later features or erosional events.

Our findings during the 1999-2000 project period will be combined with previous results and presented in a final report next year. During this investigation, we have found and documented liquefaction features and other earthquake-related deformation that provides new information relevant to the earthquake potential of the region. This project contributes to the NEHRP Element I (Evaluating National and Regional Hazard and Risk) by providing new information about the timing and magnitudes of prehistoric earthquakes and their relations to structural elements in the region. The results of this project will contribute to our understanding of the earthquake potential of the New Madrid and Wabash Valley seismic zones, as well as the Cache River Valley

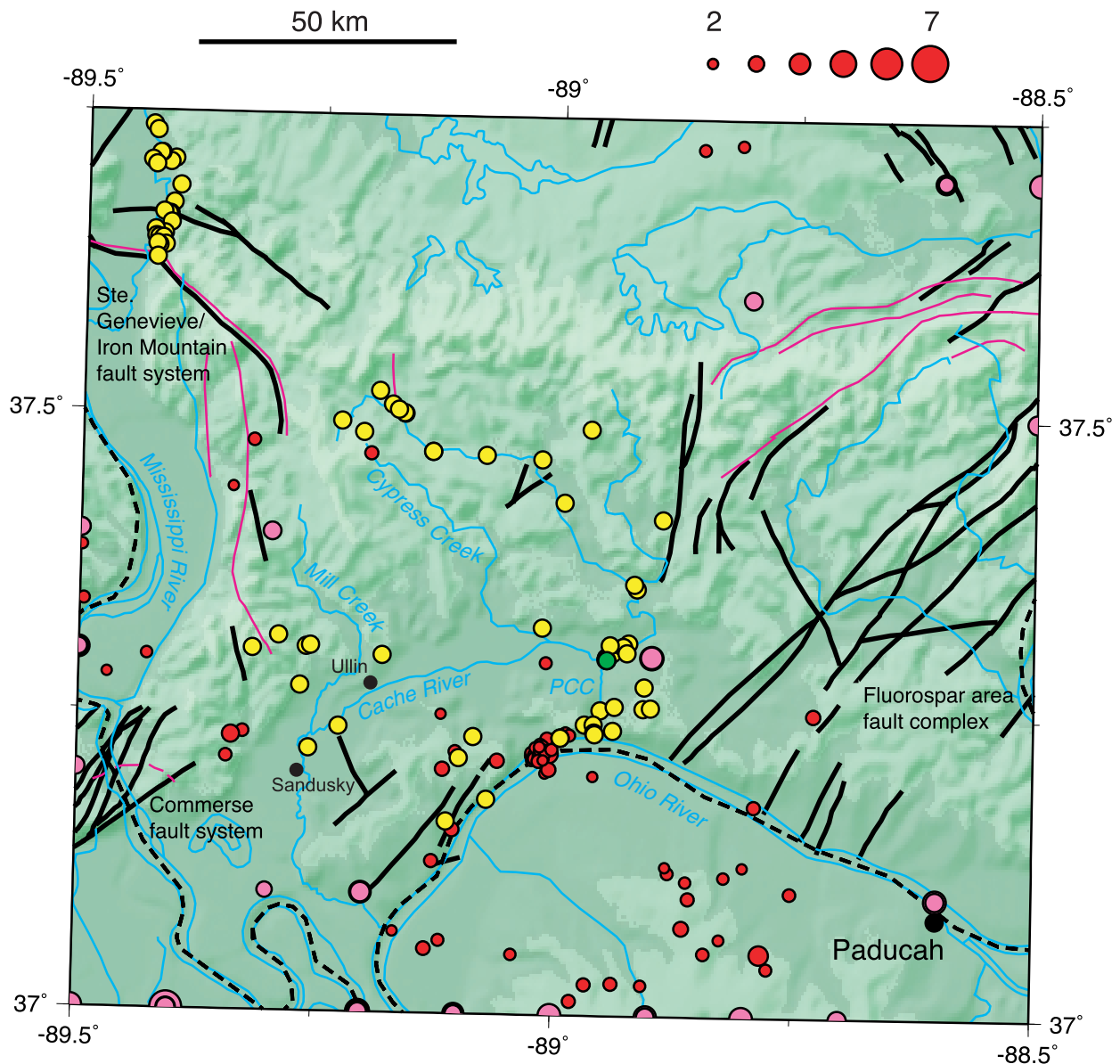


Figure 1. Study locations, seismicity and structural features on a topographic-hydrographic base map of the Cache River Valley region. Yellow circles show the study locations and the green circle shows the location of site MD-1. Red circles show the epicenters of all earthquakes of magnitude 2.0 or greater recorded by the Central Mississippi Valley Seismic Network between 1972 to present. Pink circles show the epicenters of historical earthquakes of magnitude 2.0 or greater prior to 1972 (Nuttli and Brill, 1981). Symbol size increases with earthquake magnitude as shown above the figure. The surface traces of faults and fold axes are shown with heavy black and thin magenta lines, respectively. The topographic base map is a shaded relief map where green and yellow shades represent lower and higher elevations, respectively. Shading, as if illuminated from the northwest, is used to accentuate shorter scale changes in topography. The topography is based on the 1-Degree USGS Digital Elevation Model sampled at a 9 arc-second interval. Smaller rivers, streams and other waterways and the outlines of major rivers, lakes and reservoirs are shown by cyan lines. Hydrography is based on the USGS Digital Line Graph of the 1:2,000,000-scale sectional maps of the National Atlas of the USA. Base map is a Lambert Conic Conformal projection.

area in between, and guide efforts to reduce the earthquake hazard in the central United States.

### **References Cited**

- Harrison R. W. and Schultz, A., 1994, Strike-slip faulting in the Thebes Gap, Missouri and Illinois: Implications for New Madrid tectonism, *Tectonics*, v. 13, p. 246-257.
- Hoffman, D. J., Palmer, J. D., Vaughn, J. D., and Harrison, R., 1996, Late Quaternary faulting at English Hill in southeastern Missouri, *Seismological Research Letters*, 67rd Annual Meeting, Eastern Section, Seismological Society of America, Program and Abstracts, v. 67, n. 2, p. 41.
- Nelson, W. J., Denny, F. B., Devera, J. A., Follmer, L. R., 1997, Tertiary and Quaternary tectonic faulting in southernmost Illinois, *Engineer. Geol.*, v. 46, 235-258.
- Nelson, W.J., 1995, Structural features in Illinois, Illinois State Geological Survey, Bulletin 100, 144 p.

## **Non-Technical Summary**

J. Chester (TAMU) and M. Tuttle (M. Tuttle & Associates) are performing a systematic search for and detailed study of earthquake-related features in the Cache River Valley of southern Illinois to provide information about the timing and magnitudes of prehistoric earthquakes that occurred in this region, and to identify the possible earthquake sources for these events. To date, several earthquake-related features have been found in the Cache River Valley that are suggestive of ground shaking of modified Mercalli intensity VIII-IX. Clearly, the number, ages and magnitudes of these events need to be better resolved. This study will contribute to our understanding of the earthquake potential of the New Madrid and Wabash Valley seismic zones, as well as the Cache River Valley area in between, and guide future efforts to reduce the earthquake hazard in the central United States.

## **Reports Published**

Tuttle, M., Chester, J. S., Lafferty, R., Dyer-Williams, K., Haynes, M., Cande, R., and Sierchula, M., 1998, Liquefaction features in southwestern Illinois and southeastern Missouri and their implications for paleoseismicity, EOS Trans. AGU, 79, p. S342.